National Aeronautics and Space Administration

Exploration Program Status

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NASA's Exploration Systems Mission Directorate

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A New Path: The NASA Authorization Act of 2010

- **The Congress approved and the President signed the National Aeronautics and Space Administration Authorization Act of 2010**
  - Bipartisan support for human exploration beyond Low Earth Orbit

- **The law authorizes:**
  - Extension of the International Space Station until at least 2020
  - Strong support for a commercial space transportation industry
  - Development of a multi-purpose Crew Vehicle and heavy lift launch capabilities
  - A "flexible path" approach to space exploration opening up vast opportunities including near-Earth asteroids and Mars
  - New space technology investments to increase the capabilities beyond Low Earth Orbit

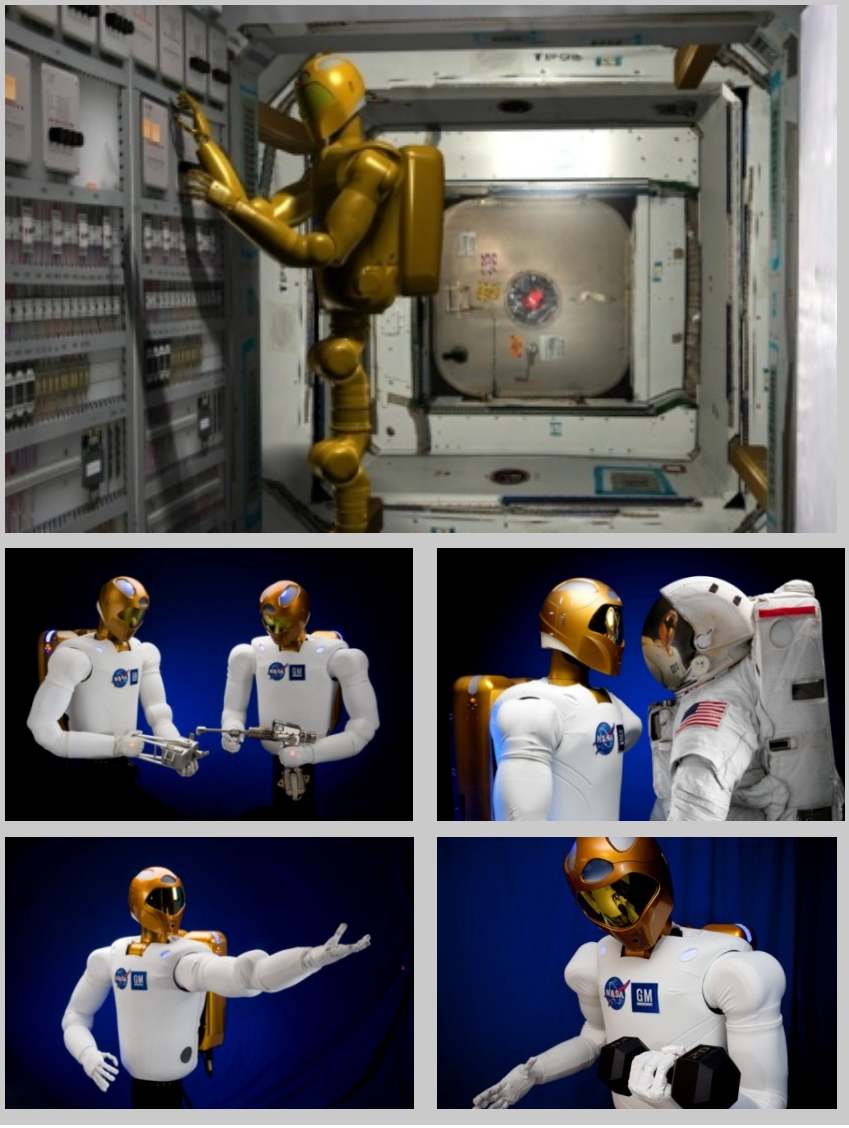
ESMD Positioned to Respond to Authorization Act

- Currently operating under a Continuing Resolution until March 4, 2011
- Using internal study teams to provide plans in response to NASA Authorization Act of 2010
  - Orion, Heavy Lift, Commercial Crew & Cargo, Technology and Exploration Precursor Robotics all reworking plans in response to the Act's provisions
- Study Team efforts are informed by Auth Act direction and results of Human Exploration Framework Team (HEFT) ongoing analysis
- HEFT is the architectural planning and analysis function for human exploration, providing decision support to NASA senior leadership on end-to-end HSF needs, which drive near-term priority decisions
  - Not a decision-making body
  - Analyses consider technical, programmatic, and fiscal constraints; their trade studies seek to drive out affordable multi-destination architecture options that meet stakeholder priorities
  - Analyses enable Agency – level strategic and technical decisions

Technology to Enable the Next Explorers To Go Beyond: Robonaut 2 (R2) ISS Flight Demo

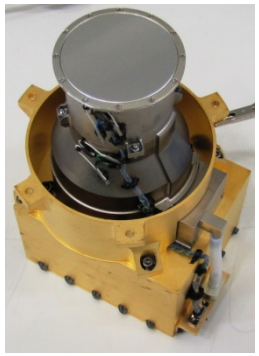
- **Experimental Objectives**
  - Test dexterous manipulation in 0g
  - Test robot-crew safety in 0g
  - Refine control based on tests
- **Experiment Plan**
  - R2 Tested IV (IV=intra-vehicle) on fixed stanchion
  - R2 Shipped with IV taskboard
  - Crew will add new experiments
- **Future Upgrades**
  - Upgrade software with revisions
  - Add mobility with 0g climbing legs
  - Upgrade backpack for mobility
  - Upgrade torso for EVA

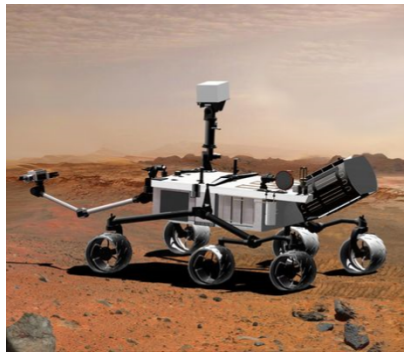
http://robonaut.jsc.nasa.gov/



Radiation Assessment Detector Integrated Into Mars Science Laboratory Rover

- **Summary:** The Mars Science Laboratory mission's Radiation Assessment Detector, or RAD, will monitor radiation both during the trip to Mars and on the Martian surface.
- **Description:** The RAD has an upward-pointing, wide-angle telescope that measures and identifies high-energy atomic and subatomic particles. These particles come directly from the sun, distant supernovas and other sources and from secondary radiation in the Martian atmosphere, rocks and soils.
- **Time Frame:** The RAD was installed in October 2010 in preparation for a November 2011 launch.
- **Space Application:** Data from the RAD will help NASA plan human missions beyond Earth orbit by reducing uncertainty about how much radiation protection future astronauts will need.
- **More information:** http://mars.jpl.nasa.gov/msl/mission/instruments/radiationdetectors/rad/





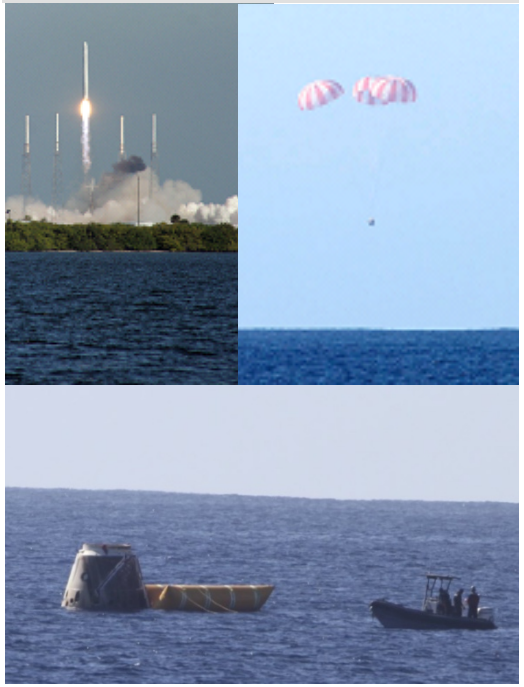
The RAD instrument, shown above, was installed in the Mars Science Laboratory Rover.
Images credit: Jet Propulsion Laboratory

SpaceX Status

- Milestones 1-17 and 20 completed for payments to date of $258M out of $278M.
- Falcon 9 maiden flight successfully reached orbit on June 4.
- COTS Milestone 17 - Demo Flight 1 successfully accomplished on December 8.
  - All primary mission objectives successfully demonstrated
    - Falcon 9 launch and Dragon insertion to orbit
    - Dragon separation
    - Safe reentry
  - All other mission objectives successful
- Demo Flight 2 mission planned for June 2011.
  - Rendezvous and proximity operations with ISS
  - ISS communication demonstration
- Demo Flight 3 mission planned for September 2011.
  - Berthing operations with ISS
  - Cargo transfer demonstration
- SpaceX has proposed combining Demo Flight 2 and 3. NASA is considering that proposal.

alcon 9 Maiden Flight, Cape Canaveral

Demo Flight 1 Images



Commercial Crew Development Round 2

- CCDev 2 Announcement for Proposals was released to industry on October 25, 2010. Proposals were due on December 13, 2010.
- The goals of CCDev 2 investments are to:
  - advance orbital commercial crew transportation system (CTS) concepts
  - and enable significant progress on maturing the design and development of elements of the system, such as launch vehicles and spacecraft, while ensuring crew and passenger safety,
  - with the overall objective of accelerating the availability of U.S. CTS capabilities.
- New competition open to all U.S. commercial providers for NASA Space Act Agreements (SAAs).
- Pay-for-Performance milestones, April 2011 to no later than May 2012.
- CCDev 2 awards are planned to coincide with the FY11 appropriation (estimated for March) which will determine the exact amount available for awards.
- ***NASA is currently in a BLACK-OUT period with industry regarding CCDev 2. All information above is public and has been previously disclosed.***

NASA's Human Rating Requirements Status

- In May 2010, NASA released to industry the first version of our commercial human rating requirements in a document titled, Commercial Human Rating Plan (CHRP).
- NASA received extensive input from industry on the CHRP and began revising it.
- NASA developed and adopted a concept known as "crew transportation system certification", as opposed to "human rating".
- NASA Authorization Act of 2010, Section 403 (b)(1), required NASA to release its human ratings processes and requirements NLT December 10, 2010.
- On December 9, NASA baselined and released the Commercial Crew Transportation System Certification Requirements for NASA Low Earth Orbit Missions document (see right).

National Aeronautics and Space Administration

CCTS Certification Requirements	Document No: ESMD-CCTSCR-12.10	
	Revision: Basic	Effective Date: December 8, 2010

Commercial Crew Transportation System
Certification Requirements
for
NASA Low Earth Orbit Missions

ESMD-CCTSCR-12.10
Revision-Basic

Douglas R. Cooke
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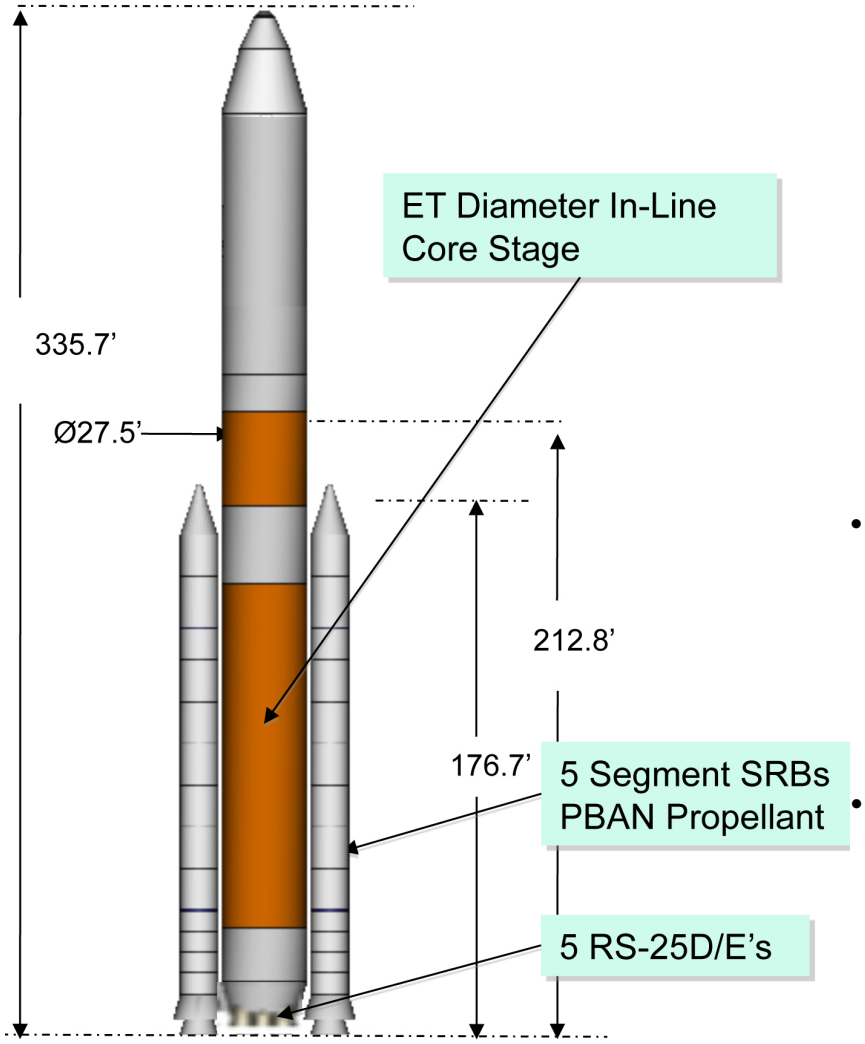
Exploration Systems Mission
Directorate

12/9/10
Date

SLS Reference Vehicle Design
Baseline SLS Path: Ares/Shuttle-derived System

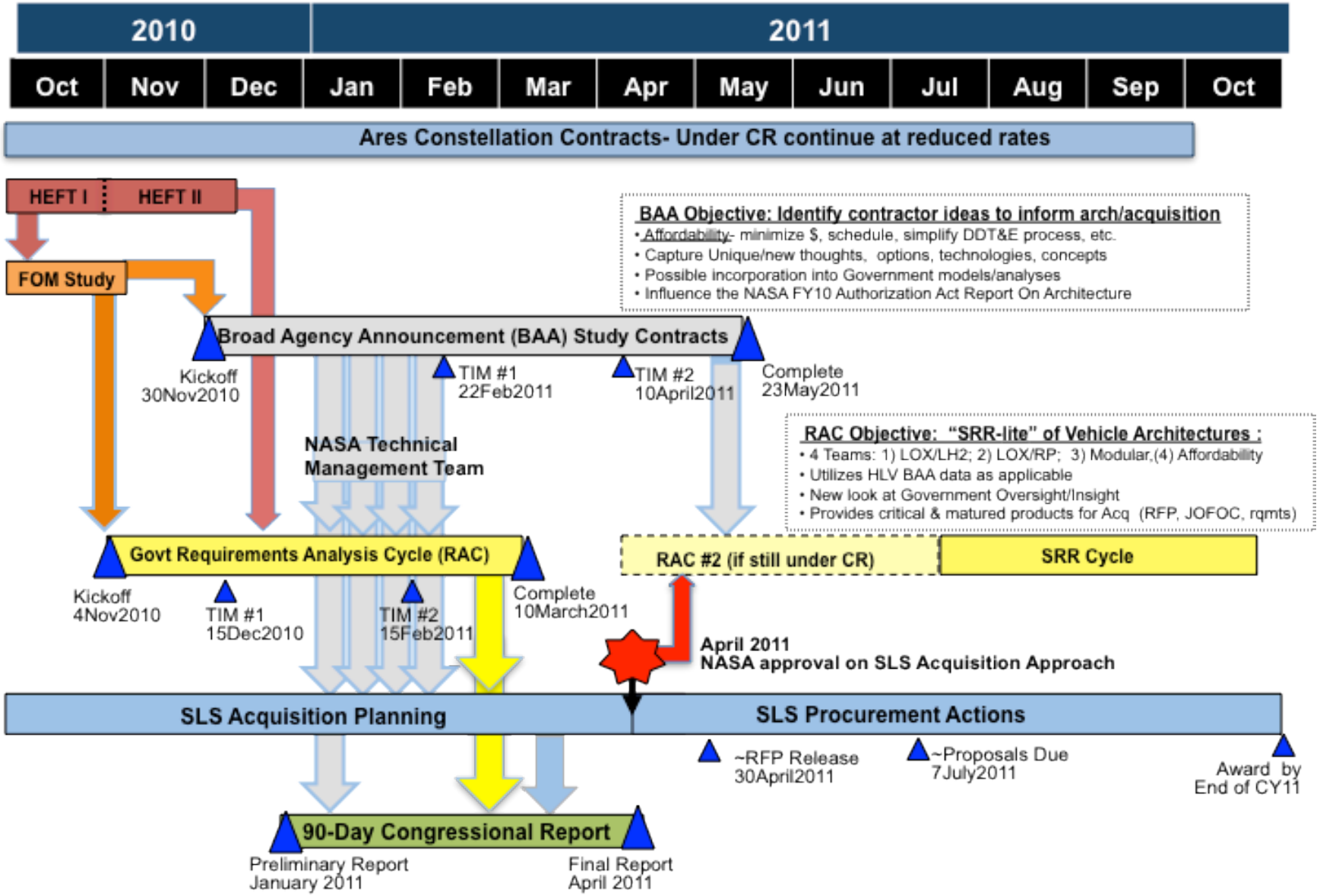


- Key Auth Act Direction
  - The Administrator shall, to the extent practicable, extend or modify existing vehicle development and associated contracts
  - The initial capability of the core elements, without an upper stage, of lifting payloads weighing between 70 tons and 100 tons into low-Earth orbit
  - The capability to lift the multipurpose crew vehicle
  - The capability to serve as a backup system for supplying and supporting ISS cargo requirements or crew delivery requirements not otherwise met by available commercial or partner-supplied vehicles
- SLS Reference Vehicle Design
  - 27.5' Diameter LOX/LH2 Core Stage
  - Five RS25 based engines using Shuttle assets then RS25E expendable derivative
  - Two 5-Segment Ares derived SRBs
  - Delivers 108.6t to 30x130 nmi
- Evolved System to 130mT
  - Upper stage with one or two J-2X upper stage engines (trades pending)
  - Draft FY11 CR language dictates concurrent development of upper stage with core vehicle

Space Launch Systems (SLS) Approach

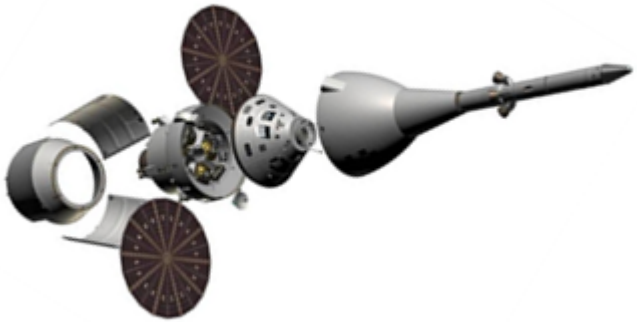
- NASA Reference Vehicle Design for SLS is an Ares/Shuttle-derived LOX/LH2 solution
  - This vehicle comes closest to meeting schedule FOM with opportunities for affordability that could bring costs down to acceptable levels
- NASA will use recently-awarded BAA study contracts and Government Requirements Analysis Cycle to validate decisions through rigorous technical and acquisition process
  - Work with industry on multiple affordability options for heavy lift
  - Validate that Ares/Shuttle derived solution is truly most cost effective
  - Provide alternative acquisition plan in event Reference Vehicle Design is unaffordable
- In parallel with SLS acquisition activities, the Constellation Ares contracts will continue through FY11 to minimize workforce disruptions
- Final decisions on NASA's plans for the SLS will be made during the Acquisition Strategy review process in early 2011.

SLS Near-term Activities



Multi-Purpose Crew Vehicle (MPCV)

- NASA Authorization Act of 2010 calls for an MPCV which:
  - Continues to advance development of the human safety features, designs, and systems in the Orion Project.
  - Serves as primary crew vehicle for missions beyond LEO
  - Conducts regular in-space operations in conjunction with payloads delivered by the Space Launch System or other vehicles in cis-lunar space (rendezvous, docking, EVA)
  - Provides means of delivering crew and cargo to the ISS as a back-up to commercial crew and international partners
- Based on these requirements, NASA has selected the beyond-LEO version of the Orion design ("block 2") as the MPCV Reference Vehicle Design



- Provides crew launch, return, and operation in deep space
- Crew size: 2 to 4
- Crewed mission duration: 21.1 days
- Delta V capability: 5233 ft/s
- Main engine thrust: 7,500 pounds
- Pressurized volume: 690.6 cubic feet
- Net habitable volume: 316 cubic feet
- Skip entries up to 4,800 nmi from lunar return trajectories
- Water landing off California coast
- 5.4 nmi landing accuracy

- Final decisions on NASA's plans for the MPCV will be made during the Acquisition Strategy review process in early 2011.